(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
16 January 2003 (16.01.2003)

PCT

(10) International Publication Number
WO 03/005764 A2

(51) International Patent Classification[7]: H04R

(21) International Application Number: PCT/GB02/03055

(22) International Filing Date: 4 July 2002 (04.07.2002)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
0116303.9 4 July 2001 (04.07.2001) GB
0200317.6 9 January 2002 (09.01.2002) GB

(71) Applicant *(for all designated States except US)*: **NEWLANDS TECHNOLOGY LIMITED** [GB/GB]; Unit 3F, Newlands Science Park, Inglemire Lane, Hull, Yorkshire HU6 7TQ (GB).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: **BROWNE, Greg** [GB/GB]; 41 Gartmoor Gardens, Southfields, London SW19 6NX (GB). **SWAN, Julian, Francis, Ralph** [GB/GB]; 174 Stanley Road, Teddington, Middlesex TW11 8UD (GB). **LACY, Graham, Keith** [GB/GB]; 19 Gosberton Road, London SW12 8LE (GB). **HAYES-PANKHURST, Richard, Paul** [GB/GB]; 51 Crabtree Lane, Fulham, London SW6 6LP (GB).

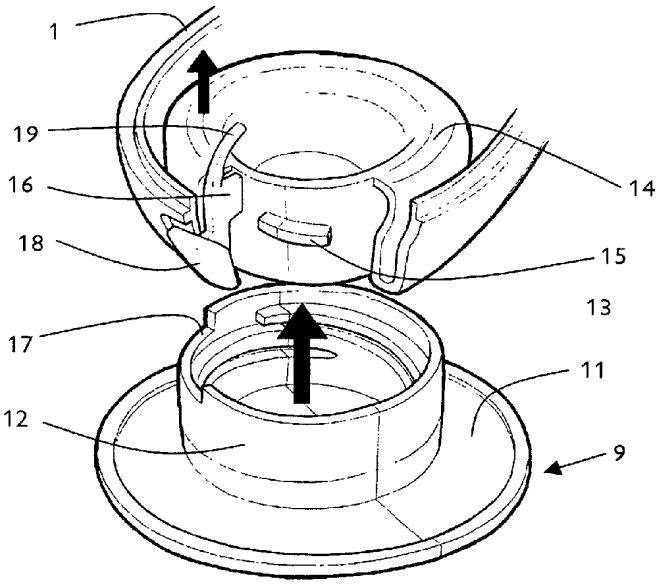
(74) Agent: **LOVEN, Keith, James**; Loven & Co, Quantum House, 30 Tentercroft Street, Lincoln, Lincolnshire LN5 7DB (GB).

(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZM, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE,

[Continued on next page]

(54) Title: PORTABLE ACOUSTIC DEVICE



(57) Abstract: A portable device is provided for coupling acoustic energy into a surface whereby the surface radiates audible sound. The device comprises a body (1) containing an acoustic actuator (6) and means (3) for energising the actuator with an audiofrequency signal, the actuator having a foot (7) for coupling the acoustic energy into the surface, and a suction device (9) for temporarily attaching the device to a surface, the suction device comprising a flexible membrane (11) surrounding the foot, and lifting means (12, 13, 15) to exert a lifting force away from the surface on said membrane, thereby reducing the air pressure beneath said membrane to hold the portable device on the surface.

WO 03/005764 A2

ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *without international search report and to be republished upon receipt of that report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

PORTABLE ACOUSTIC DEVICE

Field of the Invention

This invention relates to a portable device for coupling acoustic energy into a surface whereby the surface radiates audible sound.

Background to the Invention

It is known that a panel may be made to function as a loudspeaker by attaching to the panel an audiofrequency actuator which can transmit acoustic signals into the panel. WO-A-92/03024 discloses one such panel. WO-A-98/52289 suggests the use of standard trim panels in a motor vehicle as a means of radiating the output of a radio, tape player or the like, listing magnetostrictive, electromagnetic, electrostatic and micromotor transducers as possible for the job, although preferring piezoelectric transducers.

While such panels can be made to operate as satisfactory loudspeakers, they all depend on attachment of the actuator to the panel, and the availability of mains power or a vehicle alternator output to drive them, for various reasons. Piezoelectric devices require high voltages and relatively large currents to produce suitable levels of audio power, while electromagnetic devices, although operating at low voltages, require very high currents to produce sufficient power to produce audible output from the panels. Magnetostrictive devices can generate a substantial force at a relatively low voltage, but have previously been impractical for portable domestic uses for two reasons. Firstly, the current consumption to generate the necessary magnetic fields to cause change in length of the giant magnetostrictive material (GMM) is relatively high, and secondly, the cost of the giant magnetostrictive material is very high, and the cost of a typical GMM rod, for example as disclosed in US-A-5406153, at 6mm diameter and 50mm length, and US-A-5880542, at 38mm diameter and 54mm length, would be prohibitive.

Existing transducers need to be attached to the panel by means of adhesive or a clamping arrangement to ensure satisfactory acoustic coupling with the panel. While this is acceptable for permanent installations, it is unsatisfactory for temporary use. In our co-pending International application PCT/GB01/01184, we disclose and claim a dual-mode device which can serve both for private listening to an acoustic source and

for shared listening via a panel such as a desk or window. While adequate acoustic coupling may be achieved by simply resting the device on a suitable horizontal surface, use with non-horizontal surfaces requires some means for holding the device in engagement with the surface. The present invention seeks to provide a device which is temporarily attachable to such a surface.

Summary of the Invention

According to the invention there is provided a portable device for coupling acoustic energy into a surface whereby the surface radiates audible sound, the device comprising a body containing an acoustic actuator and means for energising the actuator with an audiofrequency signal, the actuator having a foot for coupling the acoustic energy into the surface, and a suction device for temporarily attaching the device to a surface, the suction device comprising a flexible membrane surrounding the foot, and lifting means to exert a lifting force away from the surface on said membrane, thereby reducing the air pressure beneath said membrane to hold the portable device on the surface.

Preferably, the membrane extends over the face of the foot, more preferably with a thickness less than that of the portion surrounding the foot. The lifting means preferably comprises means responsive to rotation of the body relative to the membrane to exert the lifting force. In a preferred embodiment, the lifting means comprise a rigid tube surrounding the actuator and connected to the membrane, and the tube and the body have cam means therebetween such that relative rotation between the tube and the body causes axial movement of the tube relative to the body. For example, the tube may be provided with an external screw thread, and the body is provided with cam followers engaging the thread. Alternatively, the body is provided with an internally screw-threaded portion, and the tube is provided with cam followers engaging the thread in said screw-threaded portion.

The membrane is suitably formed of an elastomeric material, for example polyurethane or a silicone rubber, and the portion of the membrane between the foot and the surface may be of either the flexible elastomeric material or a harder or softer

portion of different material from the rest of the membrane to achieve the desired acoustic coupling.

Preferably, the actuator is a magnetostrictive actuator comprising a magnetostrictive element and an electromagnetic coil associated therewith, the element being mechanically connected to the foot, and the coil being energised by the audiofrequency signal so as to cause the element to deliver an output force to the foot which is modulated by said signal.

The portable device of the invention preferably comprises within the body:

(a) a power source;

(b) an audiofrequency signal generating means; and

(c) an amplifier connected to the power source and to the signal generating means and providing an output signal to the actuator.

The signal generating means may be a player device for reproducing a recorded audiofrequency signal, for example a recording tape player, a CD player, a DVD player, or a solid state memory device. Alternatively, the signal generating means may be a radio receiver such as a radio telephone device or a broadcast radio receiver, or a receiver for a locally-radiated radio signal, for example providing a wireless connection from a local signal source.

An alternative embodiment of the device of the invention comprises:

(a) a power source;

(b) an audiofrequency signal input; and

(c) an amplifier connected to the power source and to the signal input and providing an output signal to the actuator.

The input is suitably a standard plug socket permitting an external audio signal source such as a portable tape or CD player, a solid state memory device, or a mobile telephone, to be connected thereto by means of a connecting plug lead. Thus, for example, using the device according to this embodiment of the invention, a personal audio device which normally outputs only to earphones or headphones can be made audible to a number of people at the same time, simply by temporarily attaching the device to a panel surface such as a table, or a vertical surface such as a window.

By attaching the device temporarily to the surface, not only can it be used on vertical surfaces such as windows and wall panels, or even ceiling panels, but sound quality is significantly improved on any surface, as a result of bringing the foot into firm contact with the surface to ensure efficient acoustic coupling therewith.

The attachment device may be removable to permit the audio device to be removably attached to a surface by means of a permanent fixing device which is glued or otherwise affixed to the surface and permits the foot of the audio device to be slid into and out of engagement with the surface. The permanent fixing device preferably includes spring means to urge the foot into engagement with the surface.

Brief Description of the Drawings

In the drawings, which illustrate exemplary embodiments of the invention:

Figure 1 is a sectional elevation of a device according to a first embodiment of the invention;

Figure 2 is a perspective view, partially cut away, of part of the lower portion of a variation on the device of Figure 1;

Figure 3 is a sectional elevation of the foot portion of the device shown in Figure 1, with an alternative attachment means;

Figure 4 is an exploded perspective view of the two elements of the attachment means shown in Figure 3; and

Figure 5 is a view corresponding to the left-hand portion of Figure 1, showing a modification to the device.

Detailed Description of the Illustrated Embodiments

Referring to Figure 1, the portable audio device comprises a casing 1 containing an actuator assembly 2 connected to a printed circuit board (PCB) assembly 3 containing an amplifier and power controls and supplied with electrical power from a battery 4, for example of the dry cell or rechargeable type. A cable (not shown) enters the casing 1 through a grommet 5 and connects to the PCB assembly 3; at the other end of the cable, a plug permits connection to an audio signal source, such as a personal music player or a mobile telephone.

The actuator assembly 2 consists of a magnetostrictive actuator 6, for example of the type described and claimed in our co-pending International Patent Application PCT/GB01/01184, having a foot 7 at one end thereof which protrudes through an opening 8 in the casing 1 to couple the acoustic vibrations produced by the actuator 6 into a surface, for example a table top or a window. To hold the foot 7 firmly against the surface to ensure the maximum efficiency of coupling, a removable attachment device 9 is provided, extending over the opening 8 and the foot. The attachment device 9 consists of a flexible membrane with a thinner central portion 10 overlying the foot 7, and a generally concave thicker peripheral portion 11 extending around the central portion to form a sucker attachment. The peripheral portion 11 has moulded into the upper side thereof (i.e. the side adjacent to the device, rather than the side which makes contact with the table top or window, for example) a rigid plastics generally tubular component 12 provided with inwardly-directed thread members 13. The tubular component 12 is received in an annular recess 14 in the casing 1 surrounding and retaining the actuator 6. The recess 14 is provided with cam members 15 which cooperate with the thread members 13 to enable the tubular component 12 to screw into and out of the recess 14. The effect of the rotation is to lift or lower the tubular component 12, and that portion of the membrane to which it is moulded, relative to the foot 7.

In use, the device is pressed against the surface to which it is to be temporarily attached with the foot 7 in firm contact therewith through the overlying membrane portion 10. The device is then rotated relative to the attachment device 9, causing relative rotation between the tubular component 12 and the recess 14, pulling the upper part of the peripheral portion 11 away from the surface and thereby reducing the air pressure between the portion 11 and the surface so that atmospheric pressure holds the device firmly in engagement with the surface. The configuration ensures that the foot is pressed against the surface to maximise the efficiency of acoustic coupling with the surface. Rotation of the device in the opposite direction relative to the attachment device 9 reverses the clamping process, permitting removal of the device from the sur-

face, although it may be necessary to lift the edge of the membrane to enable it to be removed freely.

The portion 10 of the membrane overlying the foot 7 is provided with a small hole 10a therethrough to assist in release of the attachment device 9 from the surface. When the device is rotated relative to the membrane to the release position, the membrane 10 is lifted off the foot 7, permitting air to flow into the space between the membrane and the surface. When the device is rotated towards the secured position, the membrane portion 10 is drawn into contact with the foot 7, thereby closing the hole and preventing ingress of air.

As may be seen from Figure 2, the attachment device 9 is prevented from being removed from the casing 1 by means of a detent 16 which extends into a cut-out 17 in the end of the tubular component 12. This enables the casing 1 to be rotated relative to the attachment device 9 by a sufficient amount to permit attachment and detachment to take place, typically about 90 degrees, but will prevent the attachment device to be removed from the casing in normal use. There may, however, be circumstances in which the removal of the attachment device 9 is desired, for example to permit its replacement if damaged. For this purpose, and to permit ready assembly of the attachment device to the casing, the detent 16 is attached to a push button 18 which is accessible externally of the casing. Finger pressure on the push button 18 slides the detent upwardly, permitting it to disengage from the cut-out 17 and thus permit the attachment device to be unscrewed from the recess 14. A resilient finger portion 19 on the upper end of the detent engages an inner part of the casing and provides a spring force biasing the detent into the locking position in the cut-out.

The device of the invention is usable on a wide range of surfaces, for example polished wood, plastics or glass, and in any orientation from horizontal to vertical, including suspension from angled or horizontal surfaces.

Removal of the attachment device may also be desirable to permit permanent attachment of the device to a surface, for example by means of adhesive, as is illustrated in Figures 3 and 4. The foot 7 is shaped so as to provide a rim 20 therearound of greater diameter than the remainder of the foot, and this may be temporarily engaged

in a fixing device 21, consisting of a generally horseshoe-shaped body 22 having an inwardly-directed sprung flange 23 therearound. The body 22 is secured to a surface, for example a vehicle windscreen, by means of a self-adhesive pad 24. The foot 7 of the device can then be slid into the fixing device 21 so that the flange 23 engages and holds the rim 20, thereby holding the foot firmly in engagement with the surface so that acoustic coupling can occur. When the audio device of the invention is required to be used elsewhere, it can simply be slid out of the fixing device 21, and the suction attachment device re-fitted.

In Figure 5, the device illustrated is essentially the same as shown in Figure 1, and will not therefore be described in detail. Fitted over the attachment device 9 is a shell 50 which extends outwardly and downwardly from the underside of the body of the device to engage the rim of the peripheral portion 11 so as to improve contact of the rim with the surface to which the device is to be attached. This in turn ensures that the foot 7 makes firmer contact with the surface, thereby improving sound quality radiated from the surface. The shell 50 can be formed of plastics material, and may be a loose fit over the attachment device, being held in place by its contact with the underside of the device, in use.

CLAIMS

1. A portable device for coupling acoustic energy into a surface whereby the surface radiates audible sound, the device comprising a body containing an acoustic actuator and means for energising the actuator with an audiofrequency signal, the actuator having a foot for coupling the acoustic energy into the surface, and a suction device for temporarily attaching the device to a surface, the suction device comprising a flexible membrane surrounding the foot, and lifting means to exert a lifting force away from the surface on said membrane, thereby reducing the air pressure beneath said membrane to hold the portable device on the surface.

2. A portable device according to Claim 1, wherein the membrane extends over the face of the foot.

3. A portable device according to Claim 2, wherein the thickness of the membrane over the face of the foot is less than that of the portion surrounding the foot.

4. A portable device according to Claim 2 or 3, wherein the membrane over the face of the foot is formed of a material having different characteristics from the remainder of the membrane.

5. A portable device according to any preceding claim, wherein the lifting means comprises means responsive to rotation of the body relative to the membrane to exert the lifting force.

6. A portable device according to Claim 5, wherein the lifting means comprise a rigid tube surrounding the actuator and connected to the membrane, the tube and the body having cam means therebetween such that relative rotation between the tube and the body causes axial movement of the tube relative to the body.

7. A portable device according to Claim 6, wherein the tube is provided with an external screw thread, and the body is provided with cam followers engaging the thread.

8. A portable device according to Claim 6, wherein the body is provided with an internally screw-threaded portion, and the tube is provided with cam followers engaging the thread in said screw-threaded portion.

9. A portable device according to any preceding claim, wherein the membrane is formed of an elastomeric material.

10. A portable device according to Claim 9, wherein the elastomeric material is polyurethane or a silicone rubber material.

11. A portable device according to any preceding claim, wherein the actuator is a magnetostrictive actuator comprising a magnetostrictive element and an electromagnetic coil associated therewith, the element being mechanically connected to the foot, and the coil being energised by the audiofrequency signal so as to cause the element to deliver an output force to the foot which is modulated by said signal.

12. A portable device according to any preceding claim, comprising:

(a) a power source;

(b) an audiofrequency signal generating means; and

(c) an amplifier connected to the power source and to the signal generating means and providing an output signal to the actuator.

13. A device according to Claim 12, wherein the signal generating means is a player device for reproducing a recorded audiofrequency signal.

14. A device according to Claim 13, wherein the player device is a recording tape player, a CD player, a DVD player, or a solid state memory device.

15. A device according to 12, wherein the signal generating means is a radio receiver.

16. A device according to Claim 15, wherein the radio receiver is a radio telephone.

17. A device according to Claim 15, wherein the radio receiver is a broadcast radio receiver.

18. A device according to Claim 15, wherein the radio receiver is a receiver for a locally-radiated radio signal, for example providing a wireless connection from a local signal source.

19. A portable device according to any of Claims 1 to 11, comprising:

(a) a power source;

(b) an audiofrequency signal input; and

(c) an amplifier connected to the power source and to the signal input and providing an output signal to the actuator.

20. A portable device according to any preceding claim, wherein the suction device is detachable.

21. A portable device for coupling acoustic energy into a surface whereby the surface radiates audible sound, the device comprising a body containing an acoustic actuator and means for energising the actuator with an audiofrequency signal, the actuator having a foot for coupling the acoustic energy into the surface, and a fixing device for temporarily attaching the device to a surface, the fixing device comprising a body securable to the surface, for example by means of adhesive and having a recess for slidably receiving the foot, the recess having a spring flange therearound to urge the foot into engagement with the surface.

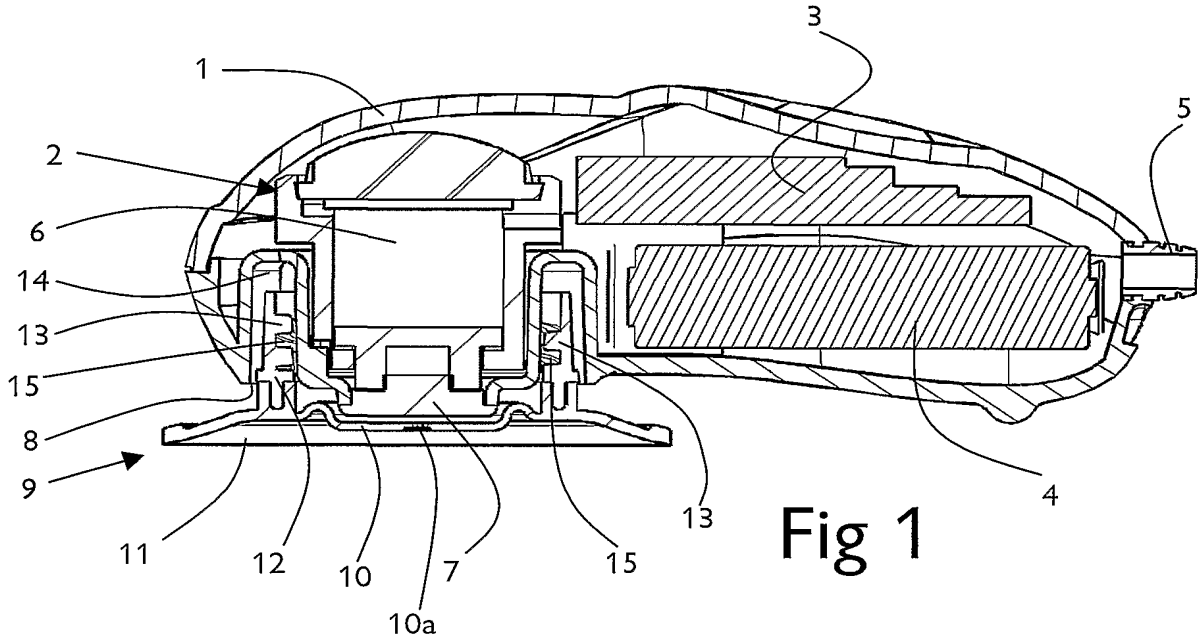


Fig 1

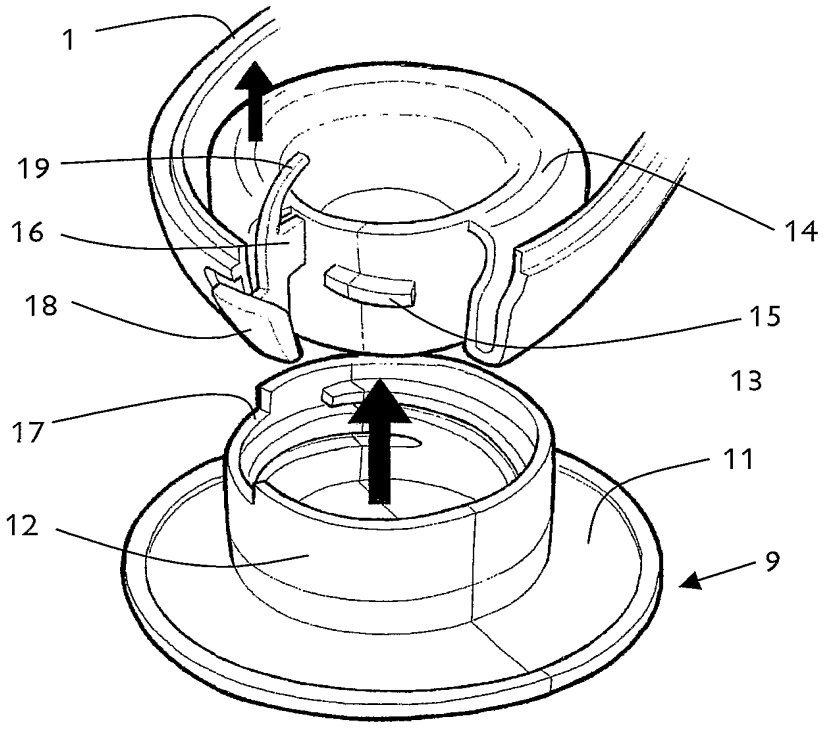


Fig 2

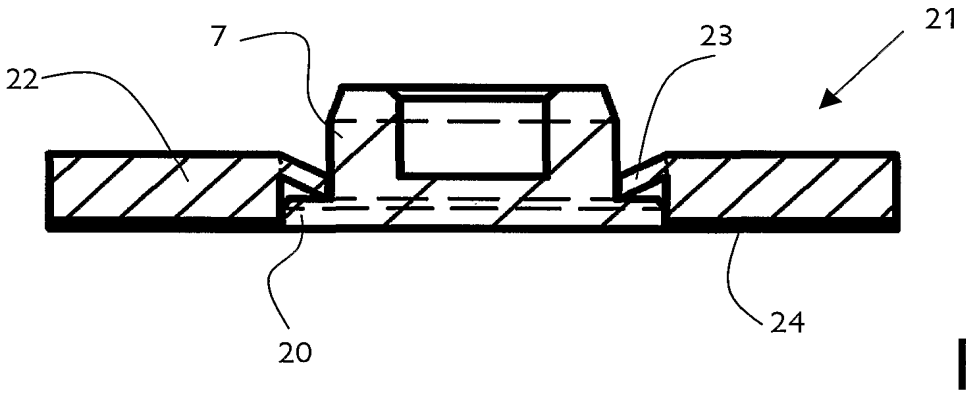


Fig 3

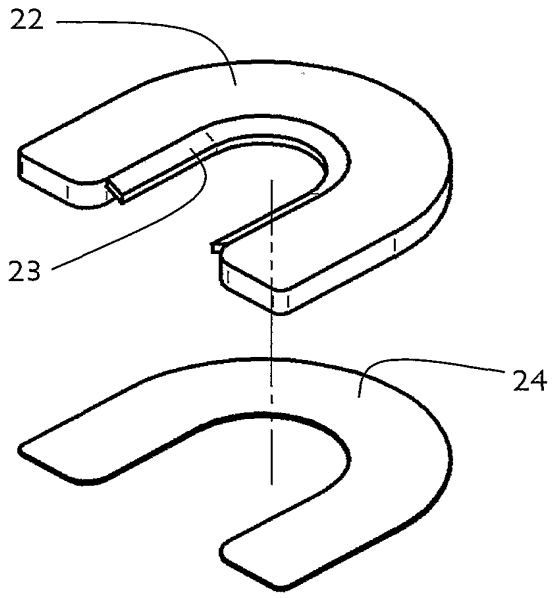


Fig 4

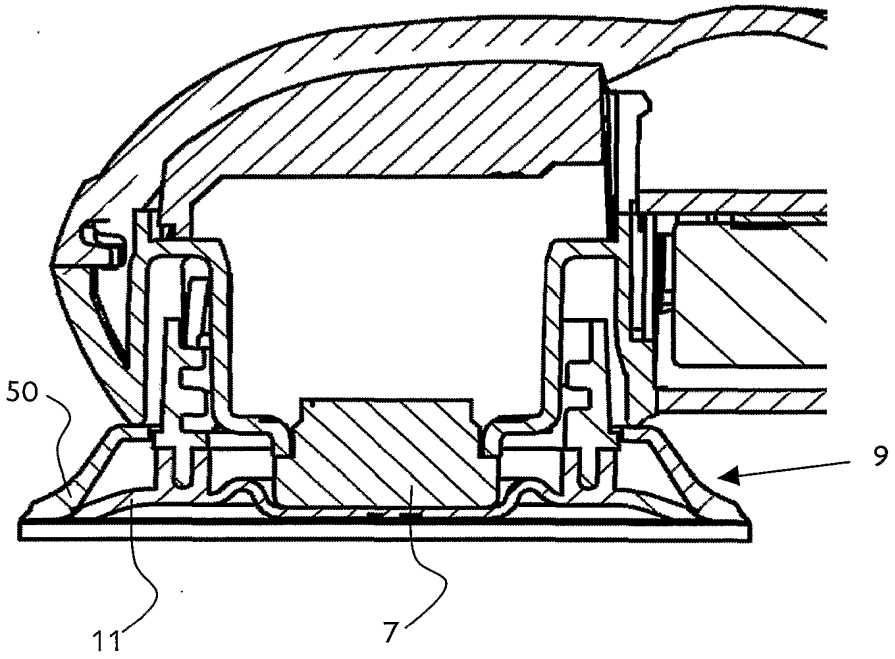


Fig 5